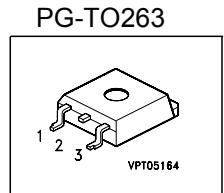


## Cool MOS™ Power Transistor

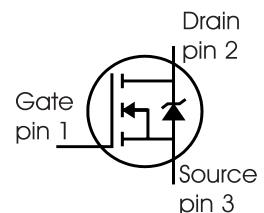
### Feature

- New revolutionary high voltage technology
- Ultra low gate charge
- Periodic avalanche rated
- Extreme dv/dt rated
- Ultra low effective capacitances
- Improved transconductance
- Qualified according to JEDEC<sup>0)</sup> for target applications

$V_{DS} @ T_{jmax}$	560	V
$R_{DS(on)}$	0.19	$\Omega$
$I_D$	21	A



Type	Package	Ordering Code	Marking
SPB21N50C3	PG-T0263	Q67040-S4566	21N50C3



### Maximum Ratings

Parameter	Symbol	Value		Unit
		SPB		
Continuous drain current $T_C = 25^\circ\text{C}$ $T_C = 100^\circ\text{C}$	$I_D$	21 13.1		A
Pulsed drain current, $t_p$ limited by $T_{jmax}$	$I_{D \text{ puls}}$	63		A
Avalanche energy, single pulse $I_D=10\text{A}, V_{DD}=50\text{V}$	$E_{AS}$	690		mJ
Avalanche energy, repetitive $t_{AR}$ limited by $T_{jmax}$ $I_D=21\text{A}, V_{DD}=50\text{V}$	$E_{AR}$	1		
Avalanche current, repetitive $t_{AR}$ limited by $T_{jmax}$	$I_{AR}$	21		A
Gate source voltage	$V_{GS}$	$\pm 20$		V
Gate source voltage AC ( $f > 1\text{Hz}$ )	$V_{GS}$	$\pm 30$		
Power dissipation, $T_C = 25^\circ\text{C}$	$P_{tot}$	208		W
Operating and storage temperature	$T_j, T_{stg}$	-55...+150		°C
Reverse diode dv/dt <sup>7)</sup>	$dv/dt$	15		V/ns

**Maximum Ratings**

Parameter	Symbol	Value	Unit
Drain Source voltage slope $V_{DS} = 400 \text{ V}$ , $I_D = 21 \text{ A}$ , $T_j = 125^\circ\text{C}$	$dv/dt$	50	V/ns

**Thermal Characteristics**

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
Thermal resistance, junction - case	$R_{thJC}$	-	-	0.6	K/W
Thermal resistance, junction - case, FullPAK	$R_{thJC\_FP}$	-	-	3.6	
Thermal resistance, junction - ambient, leaded	$R_{thJA}$	-	-	62	
Thermal resistance, junction - ambient, FullPAK	$R_{thJA\_FP}$	-	-	80	
SMD version, device on PCB: @ min. footprint @ 6 cm <sup>2</sup> cooling area <sup>3)</sup>	$R_{thJA}$	-	-	62	
-		-	35	-	
Soldering temperature, reflow soldering, MSL1 1.6 mm (0.063 in.) from case for 10s <sup>4)</sup>	$T_{sold}$	-	-	260	°C

**Electrical Characteristics**, at  $T_j=25^\circ\text{C}$  unless otherwise specified

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$V_{GS}=0\text{V}$ , $I_D=0.25\text{mA}$	500	-	-	V
Drain-Source avalanche breakdown voltage	$V_{(BR)DS}$	$V_{GS}=0\text{V}$ , $I_D=21\text{A}$	-	600	-	
Gate threshold voltage	$V_{GS(th)}$	$I_D=1000\mu\text{A}$ , $V_{GS}=V_D$	2.1	3	3.9	
Zero gate voltage drain current	$I_{DSS}$	$V_{DS}=500\text{V}$ , $V_{GS}=0\text{V}$ , $T_j=25^\circ\text{C}$ $T_j=150^\circ\text{C}$	-	0.1	1	$\mu\text{A}$
-			-	-	100	
Gate-source leakage current	$I_{GSS}$	$V_{GS}=20\text{V}$ , $V_{DS}=0\text{V}$	-	-	100	nA
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS}=10\text{V}$ , $I_D=13.1\text{A}$ $T_j=25^\circ\text{C}$ $T_j=150^\circ\text{C}$	-	0.16	0.19	$\Omega$
-			-	0.54	-	
Gate input resistance	$R_G$	f=1MHz, open drain	-	0.53	-	

### Electrical Characteristics

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Transconductance	$g_{fs}$	$V_{DS} \geq 2 * I_D * R_{DS(on)max}$ , $I_D = 13.1A$	-	18	-	S
Input capacitance	$C_{iss}$	$V_{GS} = 0V$ , $V_{DS} = 25V$ , $f = 1MHz$	-	2400	-	pF
Output capacitance	$C_{oss}$		-	1200	-	
Reverse transfer capacitance	$C_{rss}$		-	30	-	
Effective output capacitance, <sup>5)</sup> energy related	$C_{o(er)}$	$V_{GS} = 0V$ , $V_{DS} = 400V$	-	87	-	
Effective output capacitance, <sup>6)</sup> time related	$C_{o(tr)}$		-	181	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 380V$ , $V_{GS} = 0/10V$ , $I_D = 21A$ , $R_G = 3.6\Omega$	-	10	-	ns
Rise time	$t_r$		-	5	-	
Turn-off delay time	$t_{d(off)}$		-	67	-	
Fall time	$t_f$		-	4.5	-	

### Gate Charge Characteristics

Gate to source charge	$Q_{gs}$	$V_{DD} = 380V$ , $I_D = 21A$	-	10	-	nC
Gate to drain charge	$Q_{gd}$		-	50	-	
Gate charge total	$Q_g$	$V_{DD} = 380V$ , $I_D = 21A$ , $V_{GS} = 0$ to $10V$	-	95	-	
Gate plateau voltage	$V_{(plateau)}$	$V_{DD} = 380V$ , $I_D = 21A$	-	5	-	V

<sup>0</sup>J-STD20 and JESD22

<sup>1</sup>Limited only by maximum temperature

<sup>2</sup>Repetitive avalanche causes additional power losses that can be calculated as  $P_{AV} = E_{AR} * f$ .

<sup>3</sup>Device on 40mm\*40mm\*1.5mm epoxy PCB FR4 with 6cm<sup>2</sup> (one layer, 70 µm thick) copper area for drain connection. PCB is vertical without blown air.

<sup>4</sup>Soldering temperature for TO-263: 220°C, reflow

<sup>5</sup> $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

<sup>6</sup> $C_{o(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

<sup>7</sup> $|I_{SD}| \leq I_D$ ,  $di/dt \leq 200A/us$ ,  $V_{DClink} = 400V$ ,  $V_{peak} < V_{BR, DSS}$ ,  $T_j < T_{j,max}$ .

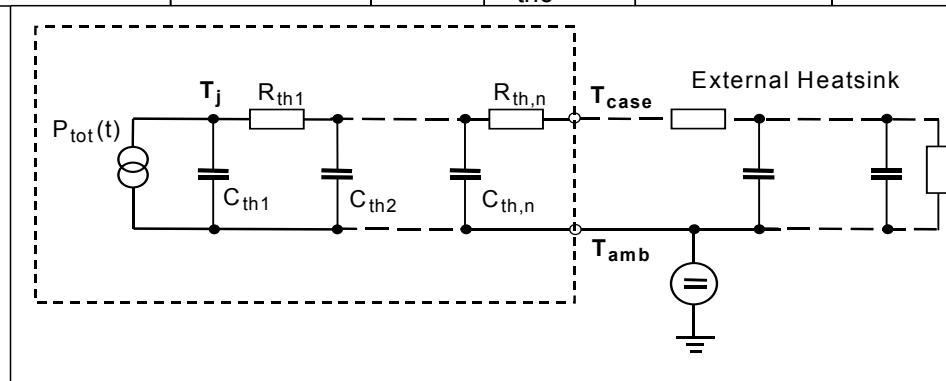
Identical low-side and high-side switch.

**Electrical Characteristics**

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Inverse diode continuous forward current	$I_S$	$T_C=25^\circ\text{C}$	-	-	21	A
Inverse diode direct current, pulsed	$I_{SM}$		-	-	63	
Inverse diode forward voltage	$V_{SD}$	$V_{GS}=0\text{V}, I_F=I_S$	-	1	1.2	V
Reverse recovery time	$t_{rr}$	$V_R=380\text{V}, I_F=I_S, di_F/dt=100\text{A}/\mu\text{s}$	-	450	-	ns
Reverse recovery charge	$Q_{rr}$		-	9	-	$\mu\text{C}$
Peak reverse recovery current	$I_{rrm}$		-	60	-	A
Peak rate of fall of reverse recovery current	$di_{rr}/dt$	$T_j=25^\circ\text{C}$	-	1200	-	$\text{A}/\mu\text{s}$

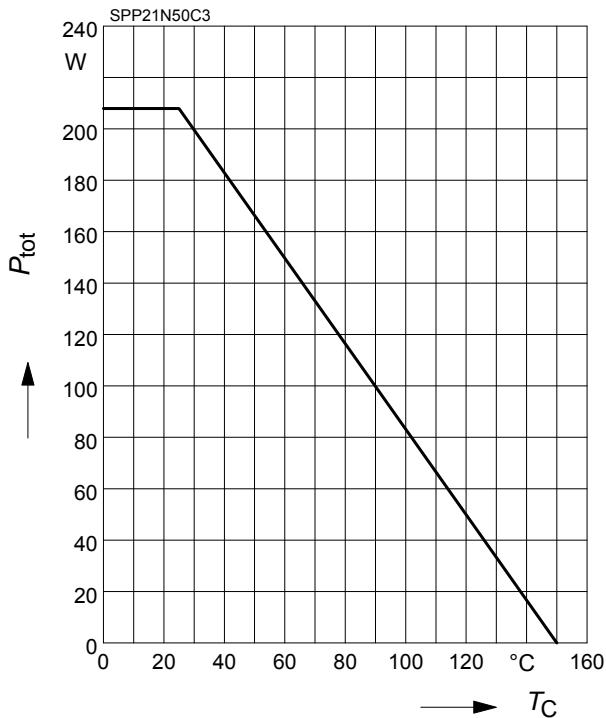
**Typical Transient Thermal Characteristics**

Symbol	Value		Unit	Symbol	Value		Unit
	SPB				SPB		
$R_{th1}$	0.00769		K/W	$C_{th1}$	0.0003763		Ws/K
$R_{th2}$	0.015			$C_{th2}$	0.001411		
$R_{th3}$	0.029			$C_{th3}$	0.001931		
$R_{th4}$	0.114			$C_{th4}$	0.005297		
$R_{th5}$	0.136			$C_{th5}$	0.012		
$R_{th6}$	0.059			$C_{th6}$	0.091		



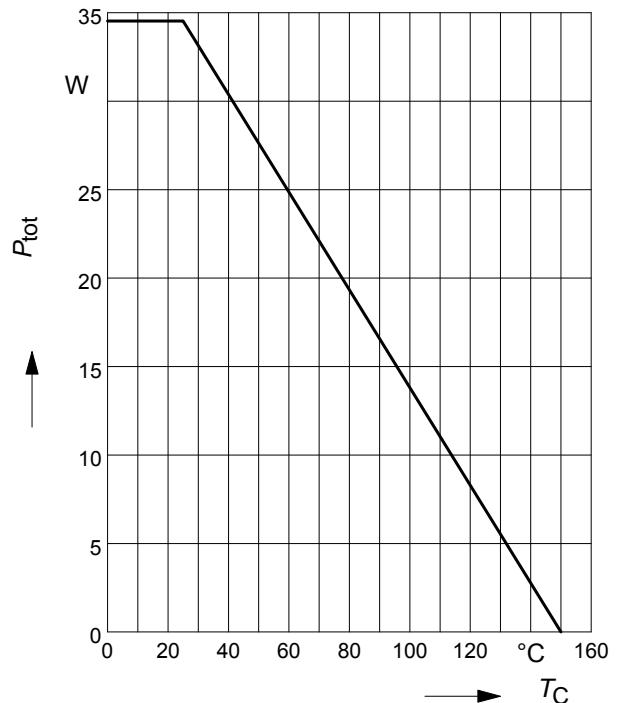
### 1 Power dissipation

$$P_{\text{tot}} = f(T_C)$$



### 2 Power dissipation FullPAK

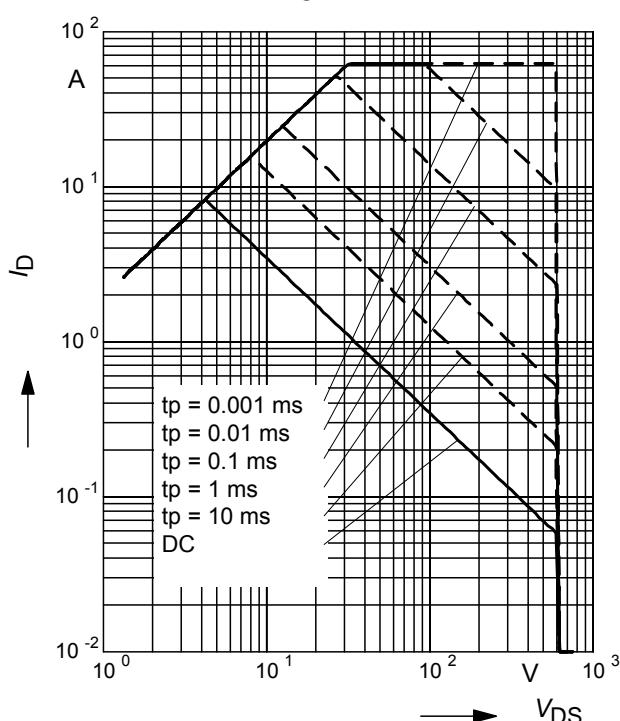
$$P_{\text{tot}} = f(T_C)$$



### 3 Safe operating area

$$I_D = f(V_{DS})$$

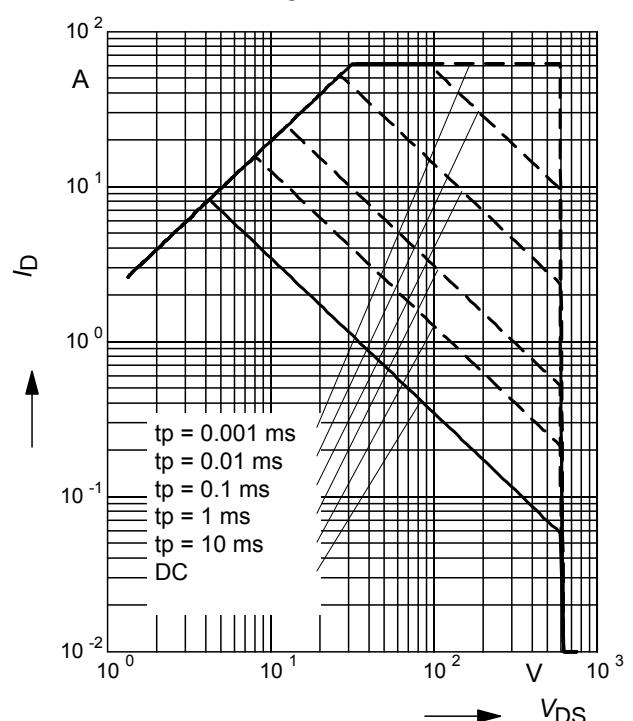
parameter :  $D = 0$  ,  $T_C=25^\circ\text{C}$



### 4 Safe operating area FullPAK

$$I_D = f(V_{DS})$$

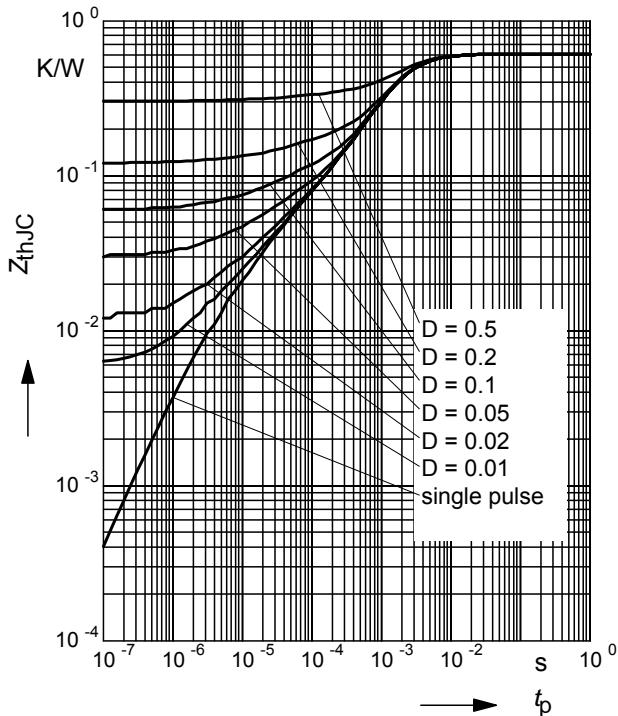
parameter:  $D = 0$ ,  $T_C = 25^\circ\text{C}$



## 5 Transient thermal impedance

$$Z_{\text{thJC}} = f(t_p)$$

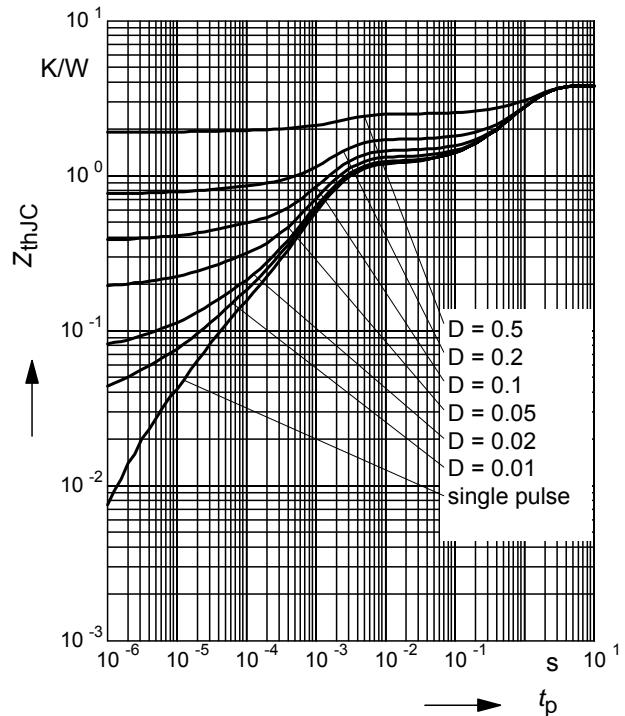
parameter:  $D = t_p/T$



## 6 Transient thermal impedance FullPAK

$$Z_{\text{thJC}} = f(t_p)$$

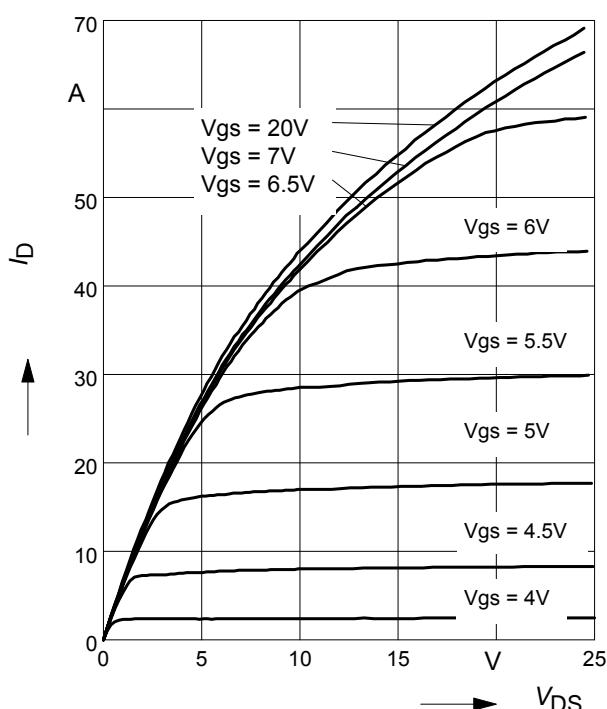
parameter:  $D = t_p/t$



## 7 Typ. output characteristic

$$I_D = f(V_{DS}); \quad T_j=25^\circ\text{C}$$

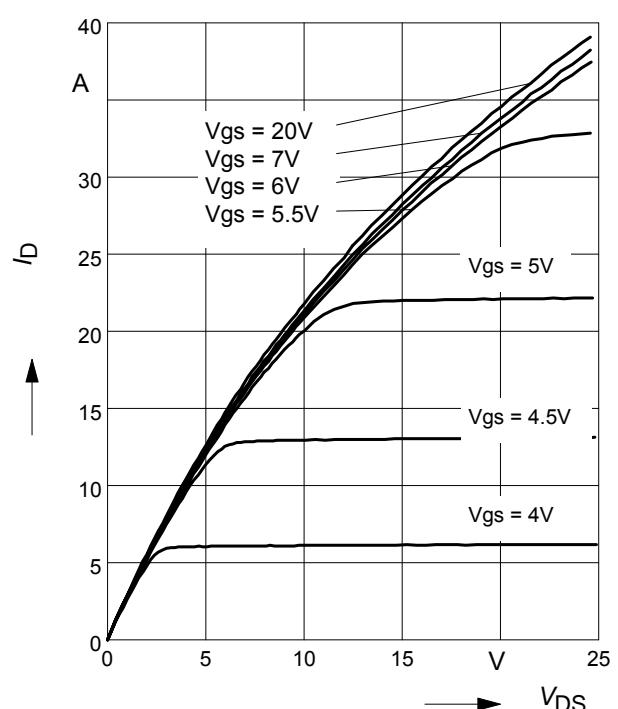
parameter:  $t_p = 10 \mu\text{s}$ ,  $V_{GS}$



## 8 Typ. output characteristic

$$I_D = f(V_{DS}); \quad T_j=150^\circ\text{C}$$

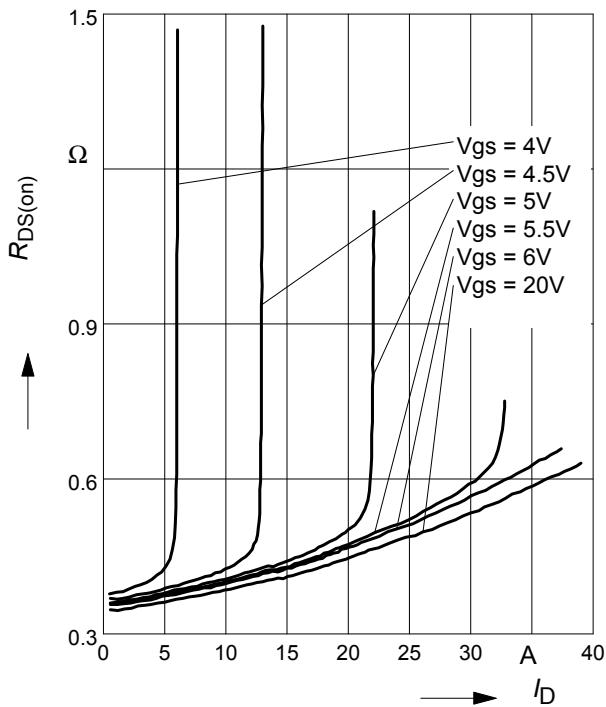
parameter:  $t_p = 10 \mu\text{s}$ ,  $V_{GS}$



### 9 Typ. drain-source on resistance

$$R_{DS(on)} = f(I_D)$$

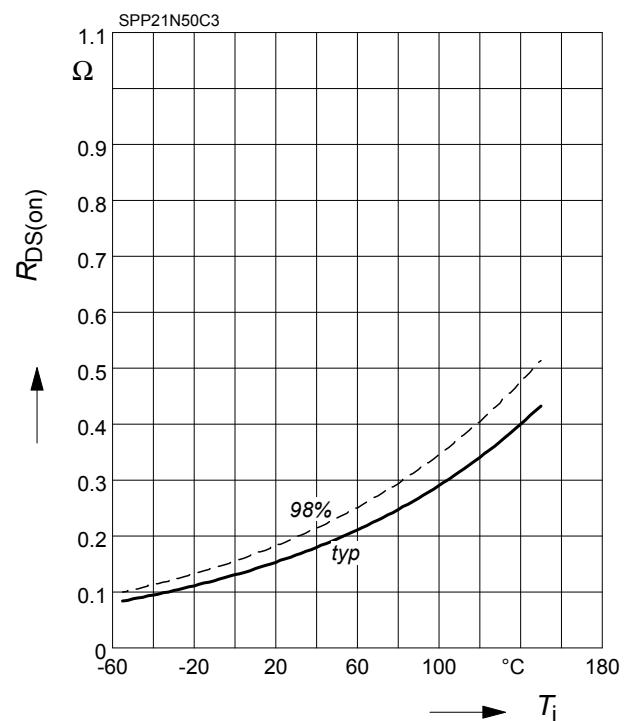
parameter:  $T_j = 150^\circ\text{C}$ ,  $V_{GS}$



### 10 Drain-source on-state resistance

$$R_{DS(on)} = f(T_j)$$

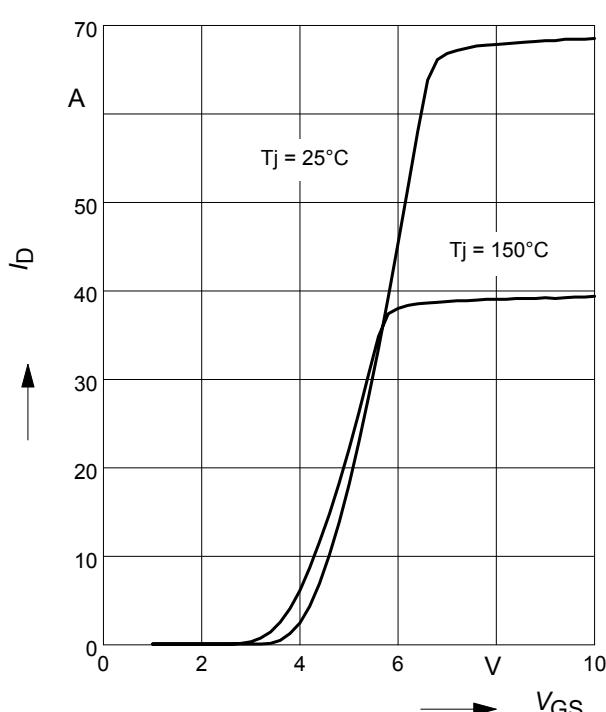
parameter :  $I_D = 13.1 \text{ A}$ ,  $V_{GS} = 10 \text{ V}$



### 11 Typ. transfer characteristics

$$I_D = f(V_{GS}) ; V_{DS} \geq 2 \times I_D \times R_{DS(on)max}$$

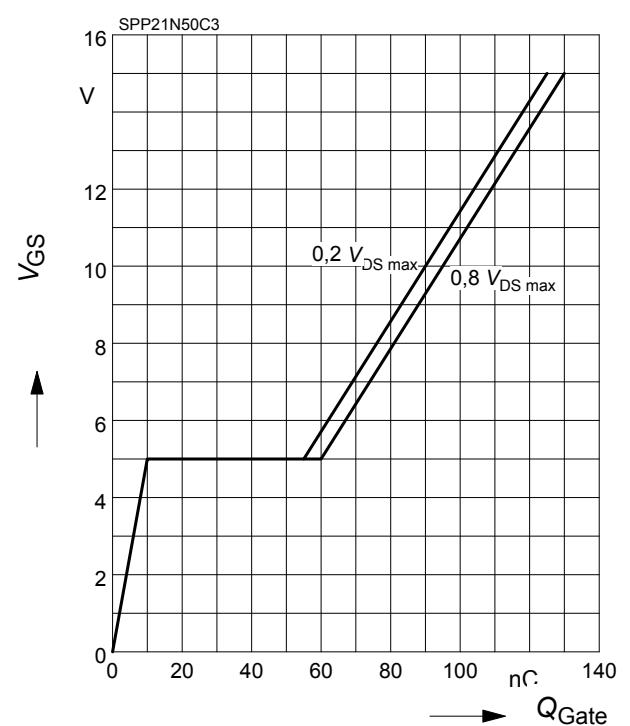
parameter:  $t_p = 10 \mu\text{s}$



### 12 Typ. gate charge

$$V_{GS} = f(Q_{Gate})$$

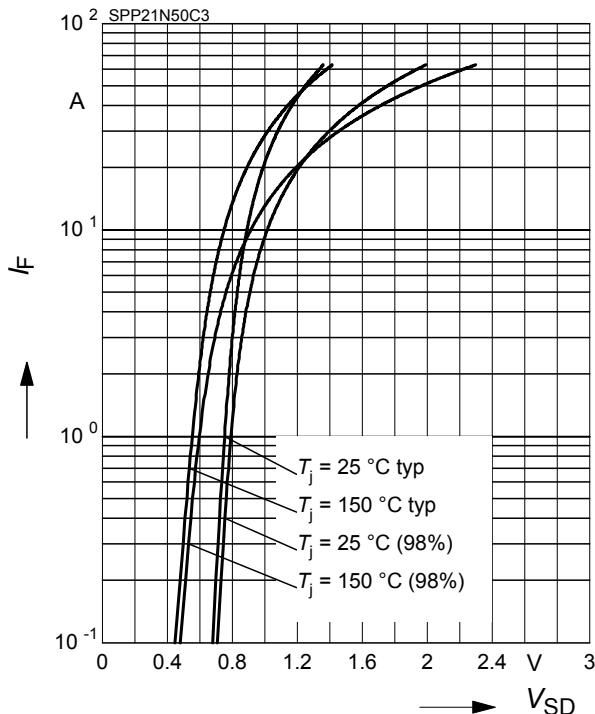
parameter:  $I_D = 21 \text{ A}$  pulsed



### 13 Forward characteristics of body diode

$$I_F = f(V_{SD})$$

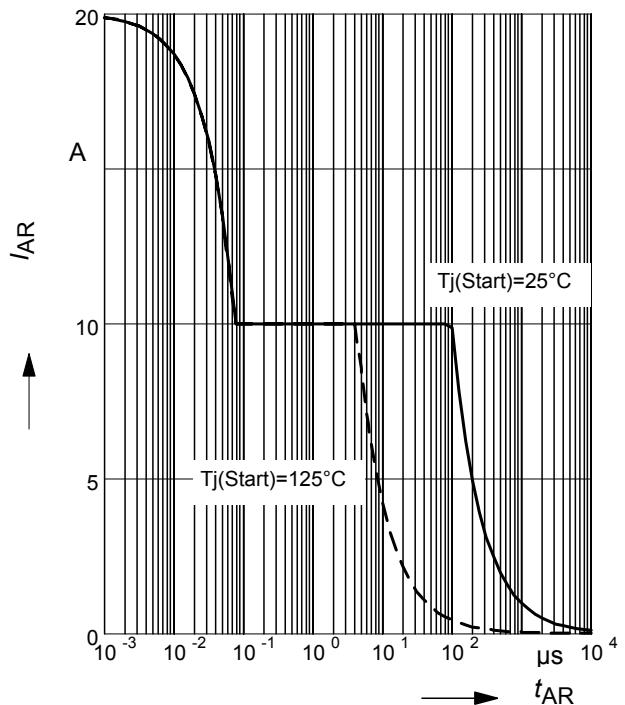
parameter:  $T_j$ ,  $t_p = 10 \mu s$



### 14 Avalanche SOA

$$I_{AR} = f(t_{AR})$$

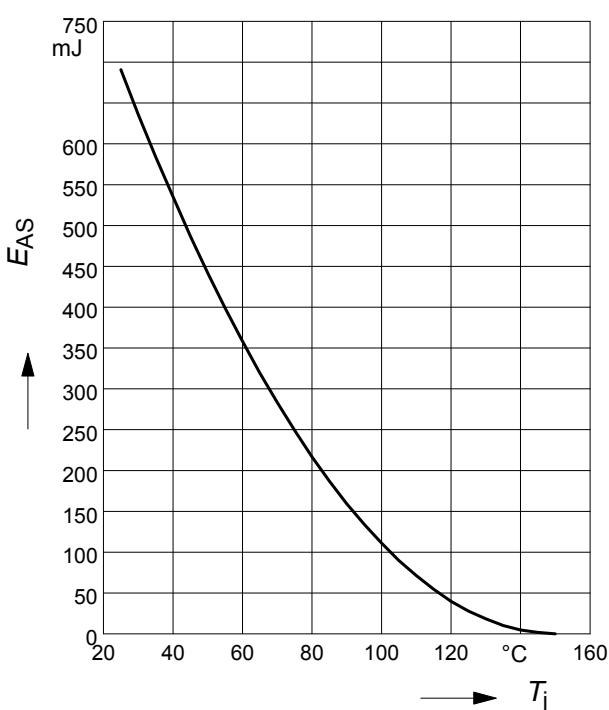
par.:  $T_j \leq 150 \text{ } ^\circ\text{C}$



### 15 Avalanche energy

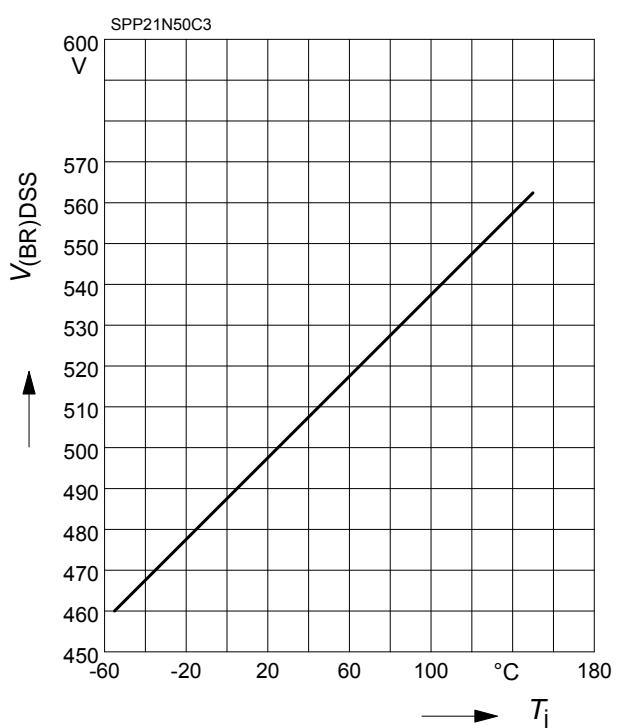
$$E_{AS} = f(T_j)$$

par.:  $I_D = 10 \text{ A}$ ,  $V_{DD} = 50 \text{ V}$



### 16 Drain-source breakdown voltage

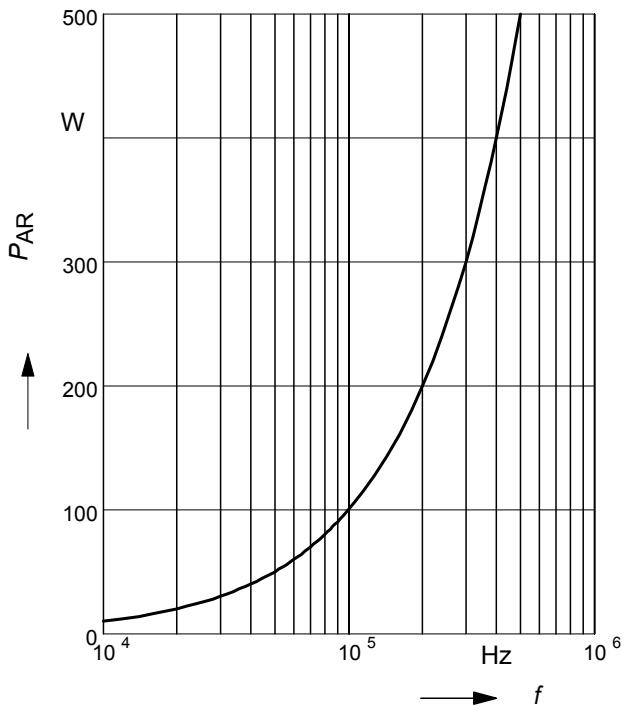
$$V_{(BR)DSS} = f(T_j)$$



### 17 Avalanche power losses

$$P_{AR} = f(f)$$

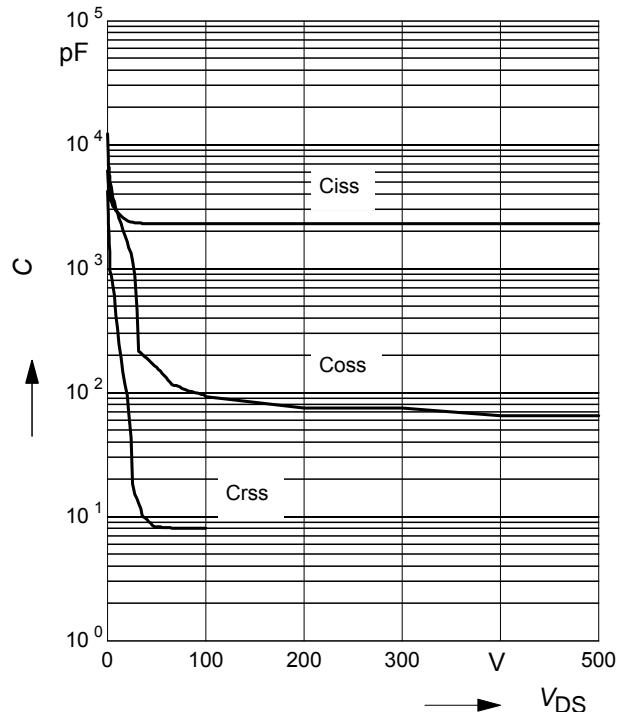
parameter:  $E_{AR}=1\text{mJ}$



### 18 Typ. capacitances

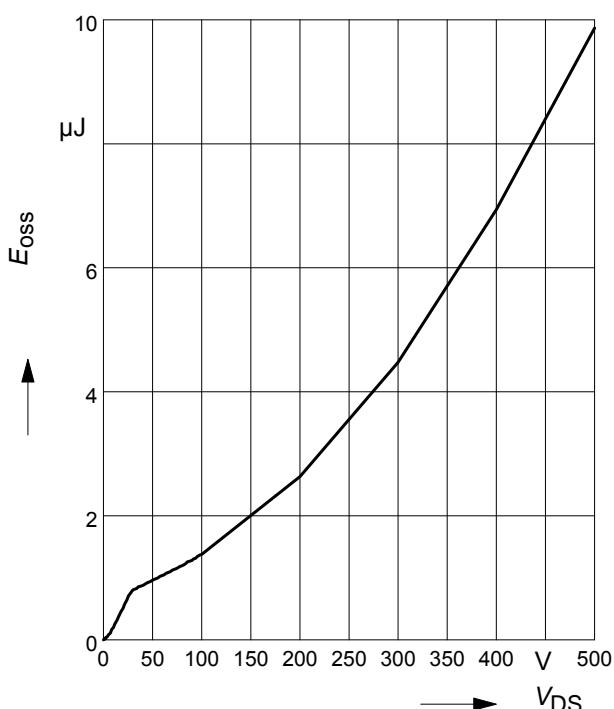
$$C = f(V_{DS})$$

parameter:  $V_{GS}=0\text{V}$ ,  $f=1\text{MHz}$

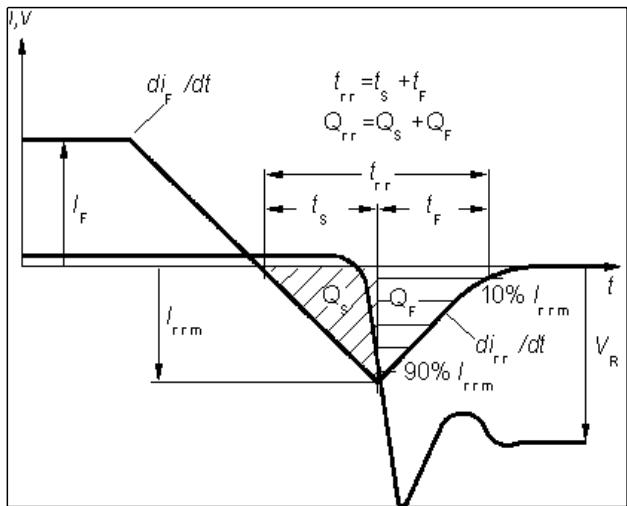


### 19 Typ. $C_{oss}$ stored energy

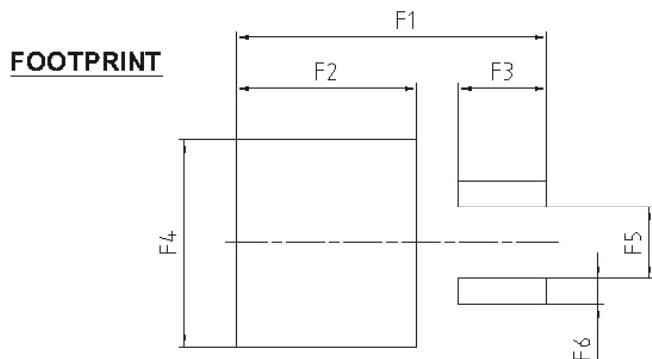
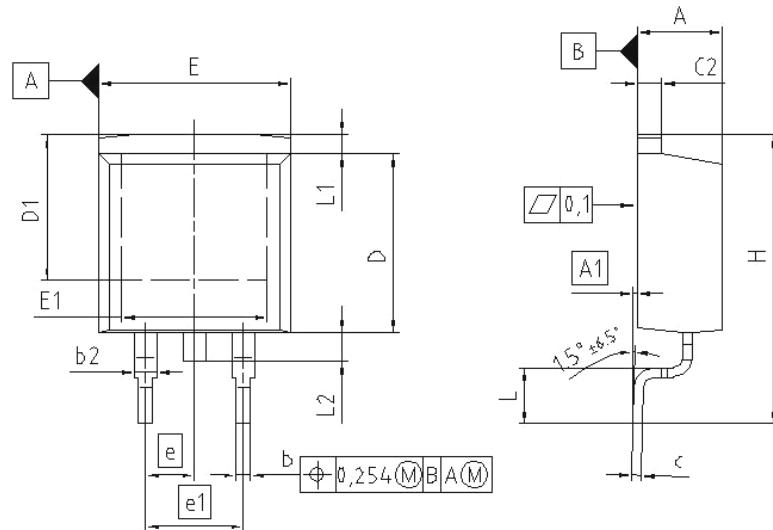
$$E_{oss}=f(V_{DS})$$



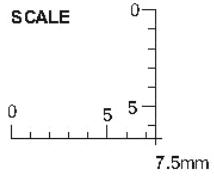
### Definition of diodes switching characteristics



PG-T0263-3-2, PG-T0263-3-5, PG-T0263-3-22



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.300	4.572	0.169	0.180
A1	0.000	0.254	0.000	0.010
b	0.650	0.850	0.026	0.033
b2	0.950	1.321	0.037	0.052
c	0.330	0.650	0.013	0.026
c2	0.170	1.400	0.046	0.055
D	8.509	9.450	0.335	0.372
D1	7.100	-	0.280	-
E	9.800	10.312	0.386	0.406
E1	6.500	-	0.256	-
e	2.540	-	0.100	-
e1	5.080	-	0.200	-
N	2	-	2	-
H	14.605	15.875	0.575	0.625
L	2.200	3.000	0.087	0.118
L1	-	1.600	-	0.063
L2	1.000	1.778	0.039	0.070
F1	16.050	16.250	0.632	0.640
F2	9.300	9.500	0.366	0.374
F3	4.500	4.700	0.177	0.185
F4	10.700	10.900	0.421	0.429
F5	3.630	3.830	0.143	0.151
F6	1.100	1.300	0.043	0.051

REFERENCE	JEDEC TO263
SCALE	0
	
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FILE	T0263_2

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